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Using dendrochronology to create a timescale of succession on nurse logs in the Olympic temperate rainforest

Sean Grealish
University of Puget Sound

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Sean W. Grealish & Carrie L. Woods

Introduction

Nurse logs are fallen trees that influence forest succession by facilitating the regeneration of forest trees.

In northern temperate rainforests of the Olympic peninsula, seedlings on nurse logs have a much higher germination and survival rate than seedlings on the forest floor, which could be due to competition with ground mosses (Harmon and Franklin, 1989).

Thus, seedling regeneration is spatially limited.

Nurse logs can take 100-200 years to decay, and the stage of decay can influence the moss and seedling communities .

The Woods lab developed a model of how moss community succession on nurse logs as they decay influences seedling germination and survival.

However, the age of the nurse log at each decay stage remains unexplored.

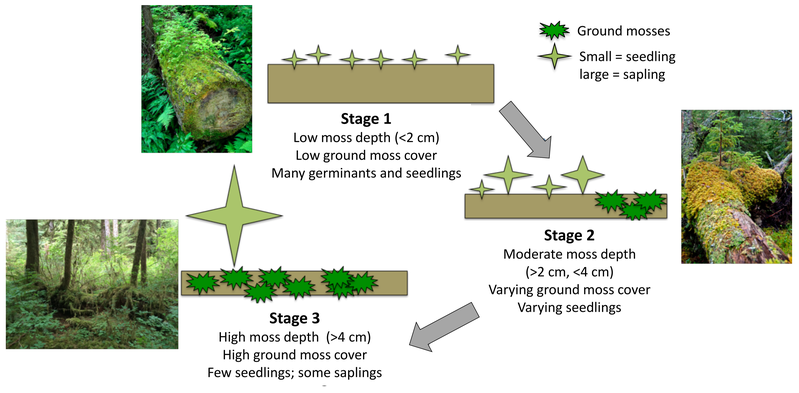

Figure 1. Succession model for seedling germination and ground moss cover throughout the decay process of a nurse log (Woods, unpublished).

Research Objectives

To define the temporal window of opportunity for seedling germination as the number of years between when a tree falls (becomes a nurse log) and when ground mosses grow over the log prohibiting survival.

Literature Cited

Harmon, M. E., and J. F. Franklin. 1989. Tree Seedlings on Logs in Picae-Tsuga Forests of Oregon and Washington. Ecology 70:48–59.

Methods

In a long-term research plot in the Olympic National Park, cores were extracted from standing Sitka Spruce and Western Hemlock trees (2-3 cores per tree) and from each nurse log as permitted by amount of decay.

Seedling and germinant numbers were recorded for Sitka Spruce and Western Hemlocks in 1 x 0.5 m plots on each nurse log along with moss composition, average moss depth and visual decay state.

The ring width of every ring in all cores was measured using a Velmex Sliding stage paired with MeasureJ2X ring width software.

By measuring the ring width for each year of nurse log growth and aligning it with the yearly average ring widths of standing trees the amount of time each nurse log had spent on the ground was determined.

Results

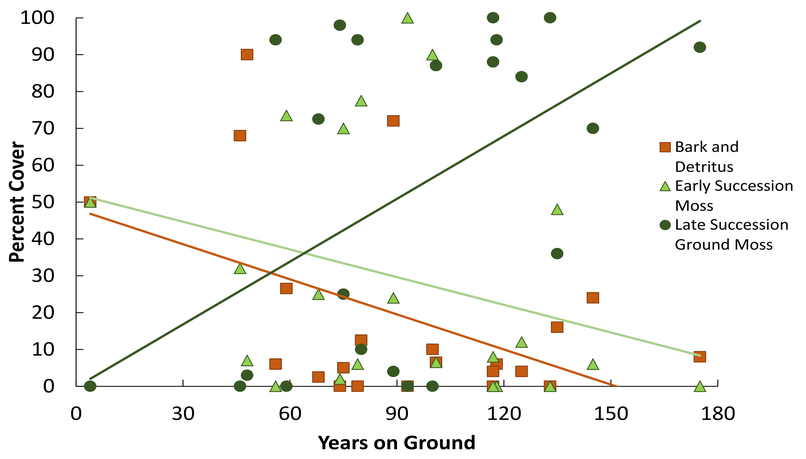

Figure 2. Relationship between percent moss cover on nurse logs and the number of years the log has been on the ground. Mosses were categorized by their common habitat (early succession mosses were predominantly found on trees and logs and late succession ground mosses were predominantly found on the ground).

With increasing years a nurse log was on the ground

- Late succession ground moss percent cover increased significantly ($R^2 = 0.27$, $p = 0.01$);
- Bark and detritus percent cover decreased significantly ($R^2 = 0.22$, $p = 0.03$);
- Early succession moss percent cover decreased with marginal significance ($R^2 = 0.09$, $p = 0.18$).

Trend lines for bark & detritus and late succession ground mosses (*Sphagnum girgensohnii*, *Rhytidiadelphus loreus* and *Hylocomium splendens*) intersect just prior to 60 years on the ground.

Following 90 years on the ground, the late succession ground mosses cover over 50% of the nurse logs and continue growing their coverage until the logs are indistinguishable from the forest floor.

Results

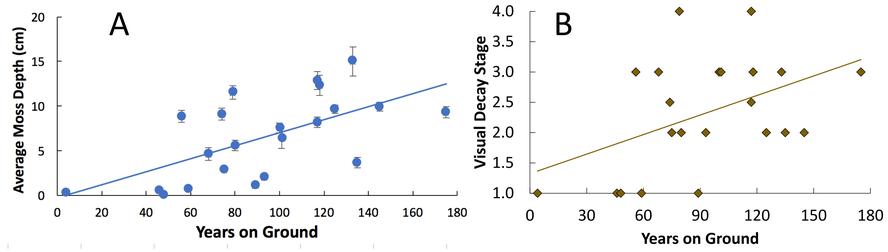

Figure 3. Average moss depth (A) and visual decay stage (B) with years since the log fell. Average moss depth increased significantly as the log spent more time on the ground ($R^2 = 0.38$, $p = 0.002$). Visual decay stage (1-5 scale) increased significantly as the log spent more time on the ground ($R^2 = 0.20$, $p = 0.04$).

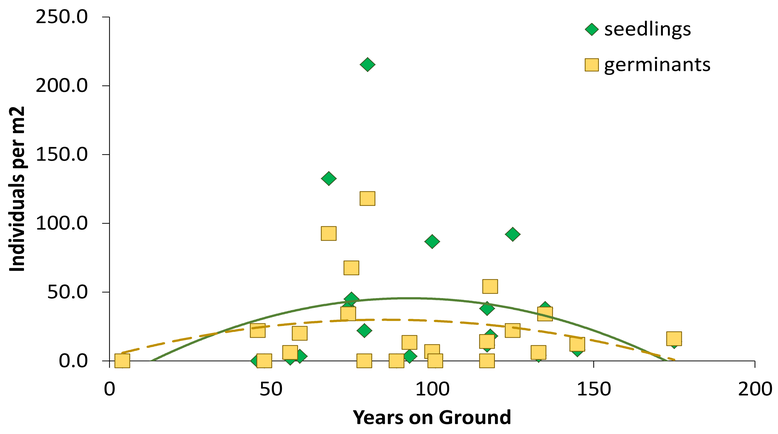

Figure 4. Seedling and germinant density with the number of years the log has been on the ground. Seedlings (solid green line) followed a non-significant second order polynomial relationship with a peak around 90 years ($R^2 = 0.13$, $p = 0.27$). Germinants (dashed yellow line) also followed a second order polynomial relationship that was not significant ($R^2 = 0.05$, $p = 0.63$).

Discussion

As nurse logs spent longer on the ground, early successional moss and bare bark are gradually covered by the dominant ground mosses with a transition zone of co-dominance between 50-70 years after the tree fell to become a nurse log.

Seedlings and germinants increase in abundance until the logs have spent 80-90 years on the ground and both decrease afterwards.

The takeover by ground mosses aligns with the period where seedlings and germinant numbers peak and begin to decline.

Thus the increase in ground mosses and linked increase in moss depth likely inhibit seedling germination and growth in Western Hemlock and Sitka Spruce on nurse logs.

Nurse logs provide a favorable substrate to seedlings for 80 years until ground mosses overgrow them.

Acknowledgements

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